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**Gatineau – Toronto 220,000 Volt Project**







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The  
Hydro-Electric Power Commission  
of Ontario

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The GATINEAU-TORONTO  
220,000 VOLT PROJECT



TORONTO - ONTARIO

October 1, 1928

Hill Gaskell

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The  
Hydro-Electric Power Commission  
of Ontario

The GATINEAU-TORONTO  
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TORONTO - ONTARIO

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# The Gatineau-Toronto Project of the Hydro-Electric Power Commission

**T**HE combined peak on the Niagara River generating stations in December, 1927, was 860,000 h.p., while the combined generating capacity available to handle this load was approximately 875,000 h.p.

Of this combined peak 560,000 h.p. was the load on the High Voltage (110 kv.) System, which is the uncontrollable municipal load. This load has been growing at approximately 10 per cent. per annum.

1923—370,000 h.p.

1924—410,000 "

1925—460,000 "

1926—510,000 "

1927—560,000 "

The generating capacity in these Niagara River plants is definitely limited by the International Water Treaty, so that, as we were already using our limit of water each day during 1927, some other source of power became an immediate necessity, to supply the uncontrollable increase in the 110 kv. system load, approximately 60,000 h.p. each year.

Additional power will now be obtained from the generating plants of the Gatineau Power Company on the Gatineau River, approximately 230 miles north-east of the city of Toronto, under a contract for the supply of 260,000 h.p. This amount represents approximately the increase in four years on the Niagara H.V. System.

Economic and engineering studies were undertaken, and, based on these

studies, it was decided to provide 2 single circuit transmission lines of 795,000 cir. mils conductor operating at 220,000 volts, with 180,000 kv-a. of transformers, in four banks of 45,000 kv-a. each, stepping down at Toronto.

As the contract provides that only 80,000 h.p. is to be delivered the first year, *i.e.*, in October, 1928, the initial programme provides one circuit only of the transmission line, with two banks of transformers at Toronto.

## TRANSMISSION LINE

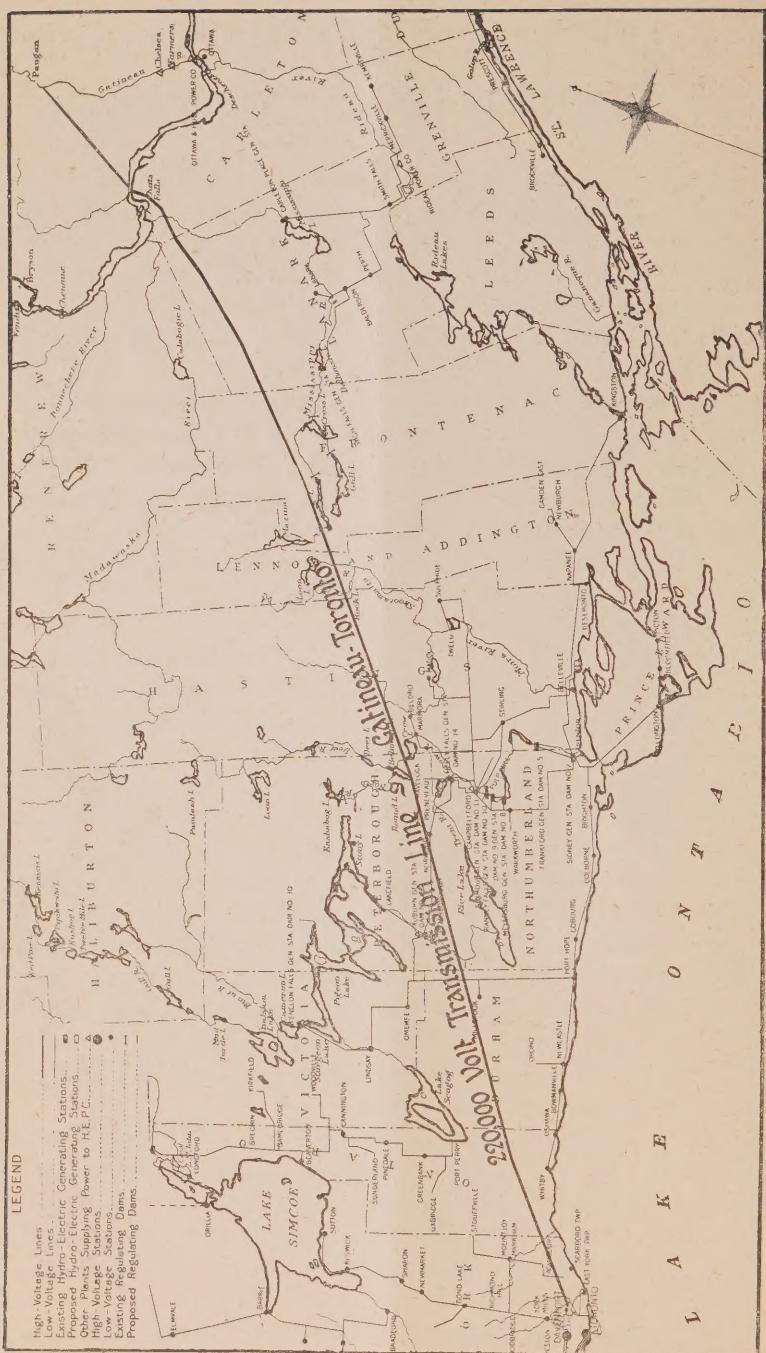
The accompanying map shows the finally approved route for the transmission line.

The route for this transmission line was surveyed in a very modern manner, by means of aerial photography. The procedure adopted was, briefly, as follows:—

The line was first located on the best existing maps. These maps are drawn to a scale of four miles to the inch, and a fair route was located avoiding major obstacles, large lakes, etc.

This route was supplied to the airplane company, and it was flown over, first from west to east, and then in the reverse direction, oblique overlapping pictures being taken along the whole route.

These pictures provided a true map of a strip of country approximately five miles in width from which the original route was checked. From



Map showing location of the Gatineau-Toronto 220 kv. line.



*Stringing conductors in the bad country approximately 150 miles east of Toronto.*

these pictures, the final route was chosen and this was flown over, taking vertical pictures. These verticals were then made into mosaics of a uniform scale of 1,000 ft., to the inch.

On these mosaics practically all of the work previously done by the field survey parties was done by a draftsman in the office. All obstructions, farm houses, etc., were clearly shown, and could easily be avoided, and using the contact pictures to obtain the major contours, tower sites could be marked directly on the mosaics. Practically the only work left to be done in the field was the running of the centre line of the right of way as shown on a copy of the mosaics supplied to the surveyor, and staking out the tower sites given.

The first of the two lines has been constructed by the Commission's Construction Department. In the 202 miles in Ontario there are 994 towers, slightly less than 5 towers to the mile. The longest span between two adjacent towers is 2,200 feet,

nearly  $\frac{1}{2}$  mile. The standard tower is 73 feet high and the total weight of steel used in the 994 towers is 12,000,000 pounds. The transmission line conductor is aluminum with a steel core for additional strength, the outside diameter being slightly over 1 inch. Three conductors are strung on each tower, giving 606 miles of conductor, a total weight of 3,300,000 pounds. This conductor is insulated from the tower by a string of 18 insulator units, the length of the string being approximately 8 feet, and the total number of insulator units being 60,000.

#### TERMINAL TRANSFORMER STATION.

Those other systems operating at 220,000 volts today, provide terminals for the 220,000 volt lines well outside of urban centres, where the transmission voltage is stepped down to some lower voltage for distribution to the transformer stations within the urban area. For this reason, it was first assumed, in studying this project that the 220,000 volt



*Final operation in tower erection, raising the centre section of the cross-arm.*

lines from Gatineau would terminate approximately  $2\frac{1}{2}$  miles north-east of the Toronto city limits. The transmission voltage was there to be stepped down to 110,000 volts, and connections were to have been provided to existing Toronto 110 kv. stations. Three winding transformers were to be installed, the low voltage tertiary windings being utilized to operate the synchronous condensers required for voltage control.

Detailed studies were undertaken of the load distribution in the city of Toronto, in order to determine the correct location of a transformer station for the east end of the city. From these studies, the idea was evolved that it was possible to so locate the Gatineau terminal station that it could also be made the distribution station for this section of the city.

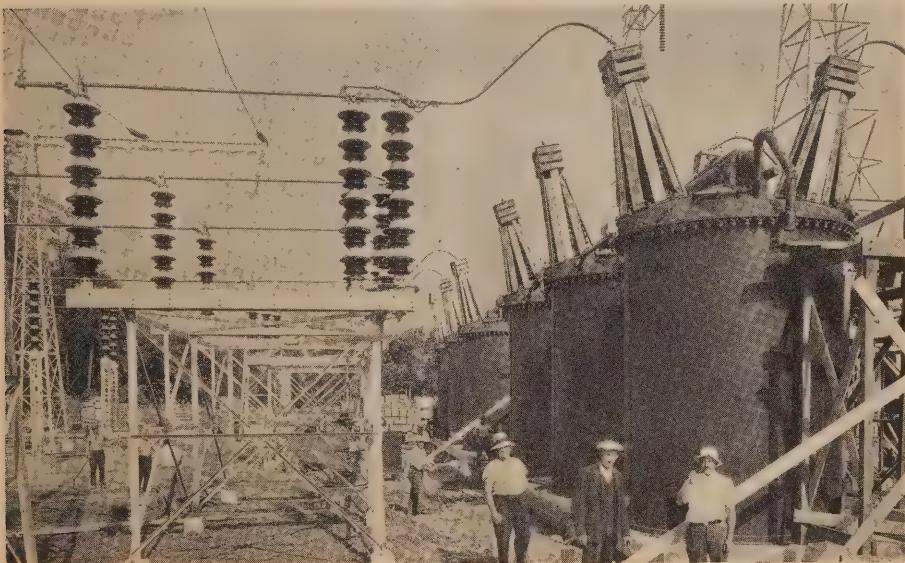
A natural right of way into the city was offered by the valley of the Don River, and an area of 12 acres

was available as a transformer station site, in a location ideally suited to the distribution of the 13,200 volt power to the eastern and northern sections of the city.

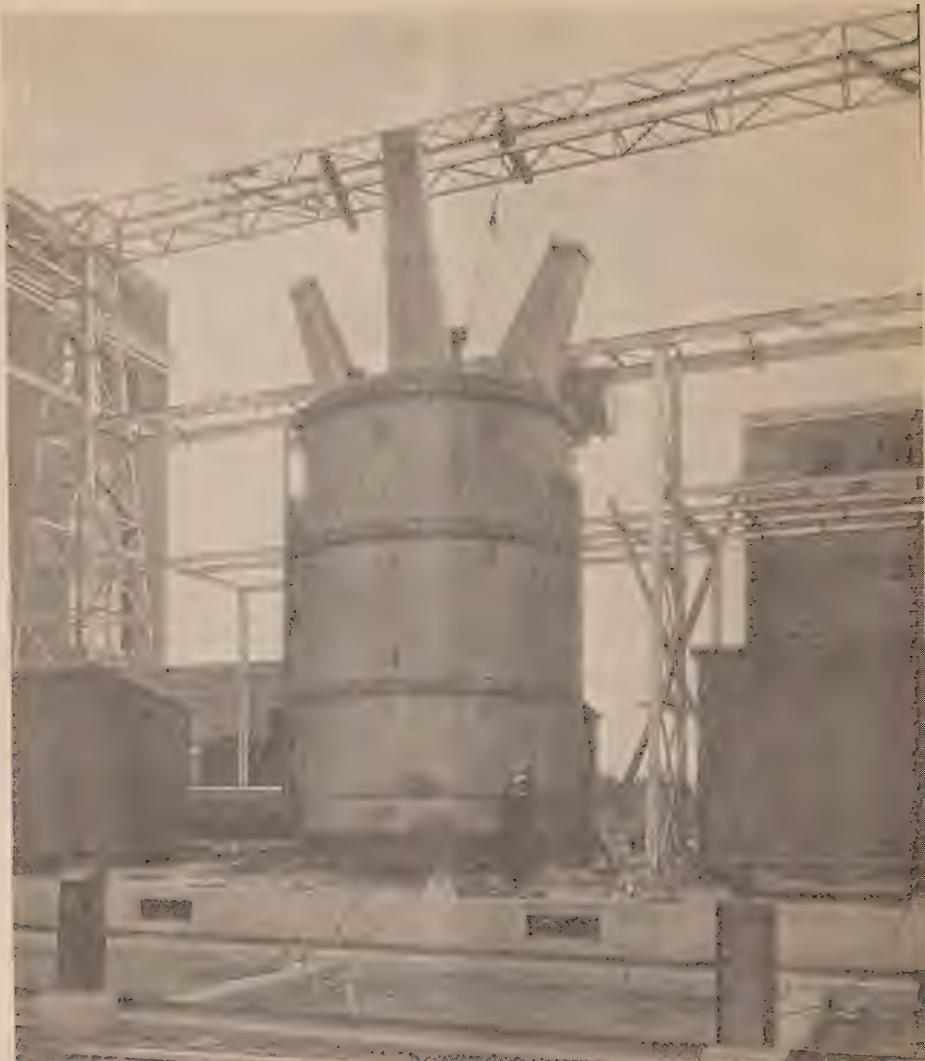
These natural advantages, plus the added economic advantage, the elimination of the second step-down, from 110 to 13.2 kv., dictated the present location of the Toronto terminal of the Gatineau lines.

#### TRANSFORMERS

The transformers are of the largest practicable size, this limit being set by transportation facilities. Each transformer is rated at 15,000 kv-a. and has three windings, so that when three transformers are connected together in a bank, they can take in 45,000 kv-a.; or 60,000 h.p., 220,000 volts and deliver part or all of it to the 110,000 volt or the 13,200 volt circuits, as desired. Four of these banks of transformers will be required to handle the Gatineau contract, the



*Some of the 220 kv. disconnecting switches and oil circuit breakers. The circuit breakers are rated to interrupt a fault current of 2,500,000 kv-a.*



*One of the 15,000 kv-a. single-phase, three winding transformers on its foundations. One of these units when filled with oil weighs 184 tons. The 220 kv. and 110 kv. bushings are seen on the top of the tank, the 13.2 kv. terminals being brought out the side of the tank, to the rear. The 110 kv., tap changing apparatus for the adjacent units may be seen on the tracks beside this transformer.*

capacity of the station therefore being 180,000 kv-a, which is the equivalent of approximately 240,000 h.p.

The 110,000 volt windings of the transformers provide a means of interconnection whereby the Gatineau

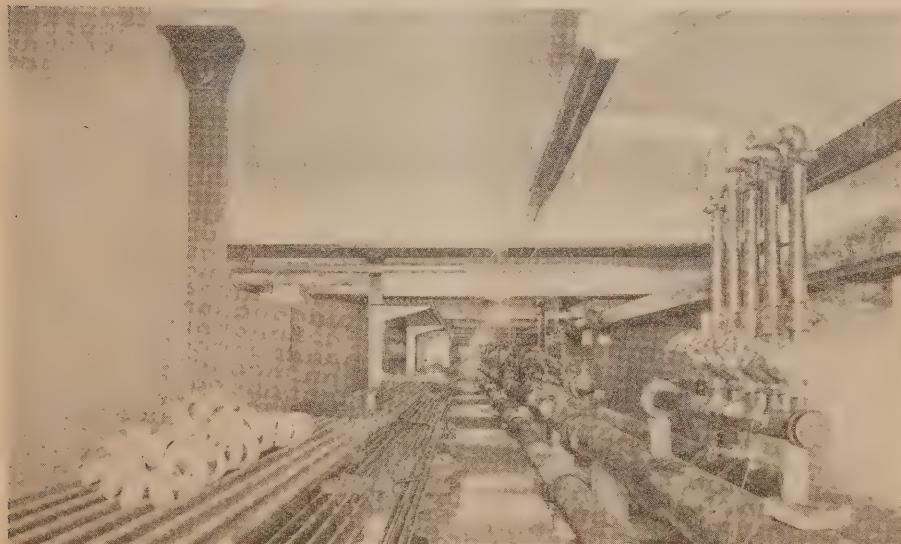
power may be taken directly into the 110,000 volt Niagara system. This connection is advantageous and necessary, because the load at 13,200 volts available at present in proximity to the station is less than the contract

amount, hence some must be absorbed at other points on the Niagara System. It also provides means whereby, in case of necessity, power could be brought in from the Niagara system through the 110,000 volt windings of the transformers to supply customers receiving power from the Leaside station. In order to provide a voltage at the 110,000 volt Leaside bus which is equal in magnitude with the Niagara System voltage at this point the transformers have been provided with load tap changing equipment which allows this voltage to be varied through a range of  $7\frac{1}{2}$  per cent. above and below normal value. The 13,200 volt windings supply the feeders of the Toronto Hydro Electric System, and since the power factor of this load must be corrected, synchronous condensers will be provided to do this.

The transformers are the largest single phase water cooled units in

physical size, ever built, as far as is known. They are 32 feet in height to the top of the high voltage terminal, and the tank is over 13 feet in diameter. Each transformer will weigh 368,000 pounds, complete, or 184 tons, and will contain over 14,000 gallons of oil. The transformer is water cooled, and requires 75 gallons of water per minute when carrying rated load. The twelve transformers will therefore require 1,300,000 gallons per day, or about the amount required for a town of 15,000 people.

The switching on the 220,000 volt side of the station is accomplished by means of large oil circuit breakers and disconnecting switches. Each oil circuit breaker is approximately 22 feet high to the top of the bushing, and occupies an area 45 by 10 feet. Each tank, of which there are three per circuit breaker requires 5,000 gallons of insulating oil. In spite of the large size of these



*The tunnel beneath the transformer foundations, showing the cooling water circulating pipes, oil pipes and corrugated pans for carrying the control and meter cables.*



*Toronto-Leaside transformer station as of April 2, 1928.*

circuit breakers, and their heavy moving parts, it is expected that they will completely interrupt the circuit in one-half second. Seven of these circuit breakers will be required to handle the contract load. The 220,000 volt circuit, after passing through circuit breakers and disconnecting switches, passes to the 220,000 volt terminals of the power transformers.

The control of all circuit breakers, disconnecting switches, tap changers and synchronous condensers is centered in a control room 35 by 45 ft. Here metering instruments will be located which will enable the operators to know at all times the conditions of voltage, power factor and load, and thus be in a position to control the equipment to best advantage, and make necessary operations in the quickest possible time. The control of the large breakers is effected by manipulating little switches no larger than the switches used for ordinary house lights, a group of these small control devices being assembled on the top of a desk about the size of the usual office desk, thus concentrating, before the operator, means of opening or closing the main

circuits. Signal lights on the desk show him at a glance the position of such apparatus.

Active work on the Leaside station was started in January last, with the construction of the service building, in which the large electrical equipment has to be erected. Certain of the work, such as the construction of the various buildings, was performed under contract by the successful tenderers. The special electrical work is being done by the Commission's Construction Department. The electrical equipment is almost entirely being built by Canadian manufacturers.

#### INTERCONNECTION OF GATINEAU AND NIAGARA SYSTEMS.

The interconnection of the Leaside terminal station with the existing Niagara system is being accomplished by means of the 110,000 volt line between Leaside and the Commission's Bridgman Avenue station. The line is constructed almost entirely on the Canadian Pacific Railway right of way through North Toronto Station, crossing Yonge Street to the south of the station itself. It will

carry two 110,000 volt circuits, and will provide a means whereby the surplus power from Leaside may be carried into the Niagara system to

relieve the Queenston generating station, and to supply emergency power to Leaside in event of a sudden interruption of the 220,000 volt system.







A panoramic view of the station showing progress to Sept. 15, 1928. This is the first unit of the station, comprising one incoming line and two transformer banks, no condenser. The railway siding, Service Building and Control Building are located on the centre line of the site and the present unit will be duplicated on the opposite side for the total Gatineau contract. The site allows for an ultimate capacity of 360,000 kw-a, i.e., 8 banks of transformers. The 220 kr. line enters the picture at the left. In Sec. 1 is the 220 kr. switching.

In Sec. 2, the steel structure for the 220 kr. ring bus is seen. In the foreground of Sec. 2 is seen the temporary out-door station for construction power. The high towers in Sec. 3 carry the 220 kr. transformer leads from the corresponding towers in Sec. 1. The pinnacles on these structures carry the station ground wires. The Service Building (for transformer erection, etc.) is seen in the background of Sec. 3, with the transformer foundations leading from it into the foreground. Two of the transformers may be seen on their foundations. In Sec. 4, is seen the 13.2 kr. switch building, containing the feeder switches.

In the foreground of Sec. 2 is seen the Control Building which is located in the centre of the site. The 220 kr. relay building is seen behind the steel structures in Sec. 2. This building is located in the centre of the 220 kr. layout. The 110 kr. switching structure is seen in Section 5, with the first tower on the 110 kr. tie-line to the Commission's Bridgeman Avenue Station, to the left in Sec. 6. The transformer cooling pond is seen in the foreground of Sec. 6.









